

## CLAIMS

What is claimed is:

- Sub A87
- 5
1. ~~A system for monitoring drill bit performance, comprising:  
a plurality of sensors located on a downhole section of the drill  
string; and  
circuitry for processing the states of said sensors to thereby derive  
a first warning state when the states of said sensors indicate that  
failure of the bit is beginning, and  
a second warning state when the states of said sensors indicate  
that final failure of the bit is at hand.~~
  2. The system of Claim 1, wherein said first warning state is indicated  
to a surface operator by variation of drilling fluid pressure, said  
variation caused by movement of a valve located in said drill  
string.
  3. The system of Claim 1, wherein said first and said second warning  
states are indicated to a surface operator by varying the position  
of a valve located in said drill string.
  4. The system of Claim 1, wherein said first warning state and said  
second warning state are independently derived, and said second  
warning state can be detected by said sensors and said circuitry  
even under some failure conditions which would preclude  
detection of said first warning state.

Sub A87

- 5 The system of Claim 1, wherein said sensors include both a first type of sensor and a second type of sensor.
6. A downhole assembly which indicates a failure condition:  
by irreversible movement of a valve which affects mud flow impedance  
from a first state which is initially present during normal drilling  
5 irreversibly into at least one intermediate state which indicates a failure condition, and thereafter irreversibly  
into a final state, which returns mud flow impedance to substantially that seen during normal drilling.
7. The assembly of Claim 6, further comprising sensors located on said downhole assembly which monitor parameters indicative of drill bit condition.
8. The assembly of Claim 6, wherein said valve movement occurs at a time constant of at least about one second.
9. The assembly of Claim 6, wherein said mud flow impedance is varied by opening an aperture which allows mud to flow from the interior of the drill string to the bore hole.
10. A method of operating a drill rig, comprising the steps of:  
monitoring downhole mud flow impedance;  
halting drilling when said impedance is altered by a downhole valve which opens or closes a shunt path for mud flow;  
5 wherein said valve changes position according to readings of one or more sensors located on a downhole sub assembly.

10036105-101701

SJA87

10036105 "101701"

11. The method of Claim 10, wherein said one or more sensors measure axial strain.
12. The method of Claim 10, wherein said one or more sensors measure vibrational frequency.
13. The method of Claim 10, wherein data from said one or more sensors are analyzed by an adaptive filter.
14. A method of operating a drill rig, comprising the step of:  
signalling a change in downhole equipment condition by causing a variation in drilling fluid static pressure.
15. The method of Claim 14, wherein said pressure variation is caused by irreversible movement of a valve.
16. The method of Claim 14, wherein said pressure variation is caused by cycling a valve through a position which restricts fluid flow and through a position which restores fluid flow to its normal state.
17. The method of Claim 14, wherein said change in downhole equipment condition is detected by a downhole sensor.
18. The method of Claim 14, wherein said change in downhole equipment condition is determined by an adaptive filter which analyzes data from sensors located on the drill string.